LUBRICATION

A Technical Publication Devoted to the Selection and Use of Lubricants

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Automatic Lubrication In The Machine Tool Industry

TODAY, the relation which exists between effective lubrication and production in industry is being more and more appreciated. It is not difficult to realize that low cost machine output is directly contingent upon efficient operation with the minimum of power consumption. And yet, there are so many operators who fail to see the "Handwriting on the Wall."

Production is their goal, all they can apparently visualize. Many in consequence completely ignore the working elements of the machinery that make this possible. If it runs, well and good. Turn on the power; overload it; perhaps give it a cleaning now and then; and finally,—when they think of it, apply an oil can or give it a shot of grease.

A happy-go-lucky routine,—until failure occurs. Failure which means, perhaps, an absolute stoppage in production. But prior to that unit costs must have been high, power bills abnormal and inaccurate work perhaps altogether too frequent.

Machine tools, especially, cannot function effectively under the handicap of abnormal friction. Nor can they cut, plane, trim or press with accuracy if clearances within bearings or between gear teeth are allowed to increase through wear.

The machine tool industry has realized these facts. In consequence developments in automatic lubrication throughout this field have been extensive and outstanding.

Machine tools are probably more universally used throughout industry than any other type of equipment except, perhaps, the electric motor. Wherever metals are to be fabricated or formed for utilization in the construction of process machinery of other industries, in the building trades, for our motor vehicles, etc., machine tools such as the lathe, planer, shaper, press, drill, milling machine, slotter, and boring mill must be employed.

SYSTEMS OF LUBRICATION

In principle the matter of automatic lubrication as applied to machine tools involves the delivery of a certain amount of lubricant to the wearing elements either at periodic intervals, or continuously during operation. The former is brought about by some method of drip feed or pressure lubrication when oil is involved, or by pressure alone when the parts in question are to be grease lubricated by certain types of compression cups.

Drip Feed Oiling

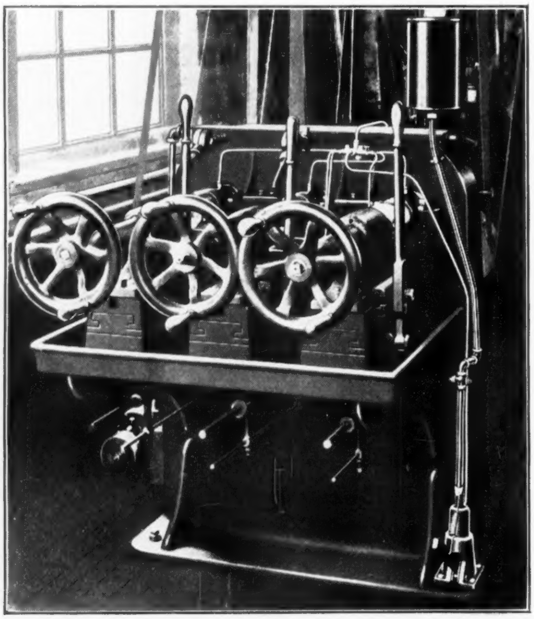
Drip feed involves the wick oiler or familiar sight feed oil cup. It is economical in first cost, but usually individual in application. With such equipment there will always be a tendency towards the development of waste in the use of oil, for such appliances must generally be turned on or off by hand and may frequently be forgotten when a machine is shut down. This, of course, might easily result in sloppy conditions about the machine, to give rise to ultimate hazards. Furthermore, the chance of breakage where oil cups are of the glass-bodied type, must also be considered. This may often prove a decided item of expense, and a hindrance to effective lubrication.

A combination of drip feed and pressure lubrication is in turn attained by use of the

mechanical force feed oiler. This will be discussed in detail later.

Advantages of Pressure

Pressure lubrication is especially advantageous where either oil or grease may be used,



Courtesy of Bowen Products Corp.

Fig. 1—A centralized pressure oiling device installed on a tapping machine. Reservoir is shown above the machine to the right, with foot pump and pedal below. Note piping therefrom to the essential bearings of the machine.

inasmuch as it more generally insures that accumulations of dirt, caked lubricant or other foreign matter will be more completely flushed or forced out from clearance spaces and oiling grooves.

Continuous Systems

Continuous lubrication, on the other hand, is attained by splash or bath oiling, or the use of some spring actuated type of compression grease lubricator. In machines employing such systems, where oil is used flood lubrication is developed to a certain extent, to thereby remove more or less of the heat that may have been generated during operation, due to high speed, insufficient ventilation, too high a viscosity in the oil, or perhaps the development of excessive friction between certain of the wearing elements of low clearance.

Potential Economies

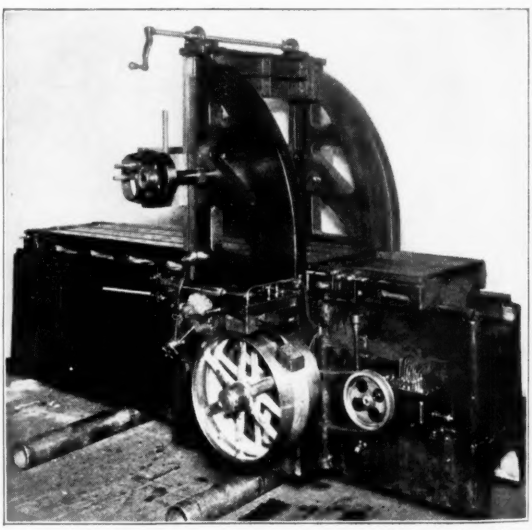
Both periodic or continuous lubrication can be rendered economical and cleanly, provided that the lubricating systems are properly designed, and the machines so constructed as to prevent oil leakage or the entry of dust, dirt or moisture. It is quite as important to protect the lubricant after it has been put into service as to select it with care in the beginning. In fact, judicious selection, adequate protection, and proper cleansing at periodic intervals, will markedly extend the life of machine wearing elements, reducing oil bills and the cost of upkeep at the same time in a most agreeable manner.

Essentials of Pressure Lubrication

As its name implies, pressure lubrication involves the delivery of the lubricant to the wearing elements by means of more or less pressure according to constructional conditions, and the amount of clearance between parts in motion with respect to one another. As a general rule, pressure lubrication will be particularly applicable to certain of the bearings of many types of machine tools.

It is practicable, of course, to use either grease or oil in this manner, all according to the provisions for application. Oil requires pumping; grease, on the other hand, is most easily applied by some form of pressure gun or constant pressure lubricator which can be periodically filled with such a gun.

Pressure lubrication by means of oil may be intermittent or continuous, dependent upon the type of pump employed, or the practicability of using gravity circulation. The geared pump,



Courtesy of Madison-Kipp Corp.

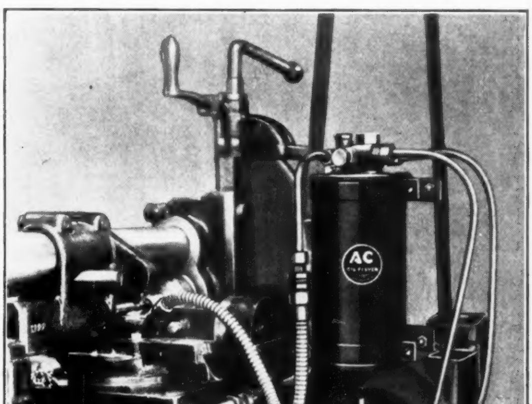
Fig. 2—A mechanical force feed lubricator installed on a Whitcomb planer. With this device the rate of oil delivery is dependent upon the speed of the machine and the moving element which operates the respective pumps.

akin to the type so extensively used in the lubrication of automotive engines is more adaptable in this regard than the use of overhead storage tanks which gravity circulation requires. Such pumps can be built into the machines themselves, the amount of external

piping involved is small, and there is usually but little possibility of breakage or damage from any external source. In the operation of some machines, where stock is heavy and bulky, and where cuts may be deep, this will be an important matter.

Mechanical Force Feed Lubrication

The mechanical force feed lubricator, on the other hand, delivers oil to machine tool bearings at periodic intervals, according to the setting and stroke of the respective pumps. A device of this nature is of value in that oil may be delivered to the bearings, in varying amounts, according to their requirements, based on speed, size, clearance and operating temperatures. Furthermore, different grades of oil can be used in the same device by selecting a lubricator with the requisite number of storage compartments. In this way the approximately correct viscosity can be obtained in the lubricating films to meet the bearing pressures involved.

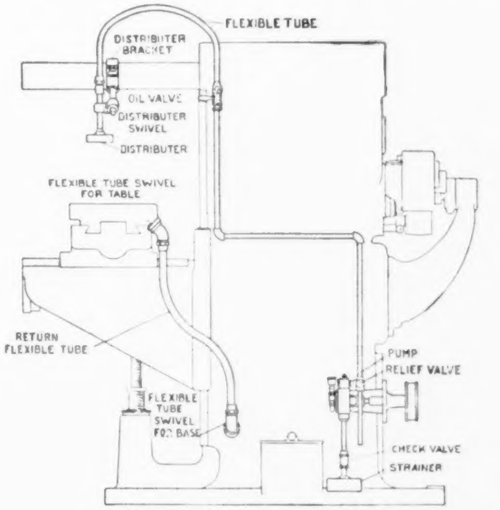


Courtesy of A. C. Spark Plug Co.

Fig. 3—An oil filter installed showing manner of location of such a device on a modern machine tool. The importance of clean oil in the attainment of greater accuracy in cutting is self-evident where maximum production of finely machined parts is essential.

Grease Lubrication

Grease, of course, is decidedly applicable to the lubrication of many of the wearing elements on certain machine tools. As a general rule, however, it requires individual servicing of the parts involved in much the same manner as with the grease-lubricated automobile chassis. On the other hand, it permits of the treatment of each, in accordance with its specific requirements, using more or less lubricant according to constructional conditions, bearing pressures and operating temperatures.



Courtesy of Brown & Sharpe Mfg. Co.

Fig. 4—An arrangement of oil piping for a milling machine showing in detail the pump with accessories, the distributing system and the flexible tube which returns used oil to the reservoir in the base of the machine.

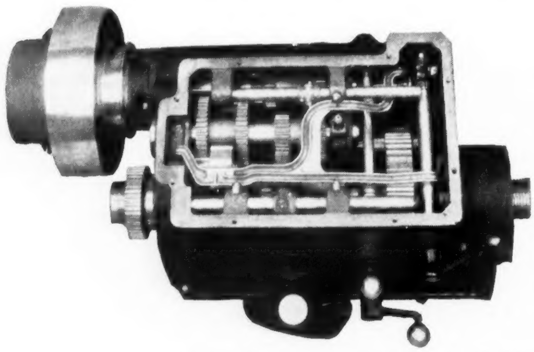
Lubrication of this nature can, of course, be rendered automatic in many instances according to the type of lubricating equipment and the amount of grease charged. It is not as flexible a method as oil lubrication, however, in that to serve a number of parts from the one source of supply will usually require the installation of comparatively expensive equipment.

Pressure grease lubrication by any method whereby adequate pressure can be imposed on the grease to be used, commensurate with its consistency, is decidedly advantageous on parts where bulky lubricators might be in the way, and where motion is such as to not require too frequent application. The grease gun, furthermore, is a more cleanly piece of equipment than the oil can, and insures that there will be less possibility of lubricants becoming contaminated prior to application.

Details of Lubricator Construction

There are certain devices available which make use of a spring actuated plunger within a small container or grease reservoir. Charging is carried out by application of a pressure gun to a suitable filling point. As the lubricator is filled, the plunger is forced upward to compress the

spring. In certain types of lubricators an extension rod attached to the plunger and extending above the top of the lubricator serves as an indicator in regard to the amount of grease contained. Lubricators of this nature are economical and automatic in action, being claimed to



Courtesy of The R. K. LeBlond Machine Tool Co.

Fig. 5—Interior view of the selective speed geared headstock of a heavy duty engine lathe. Splash lubrication is involved, the head being partly filled with oil to a definite level. Oil is carried by the rotating gears to a rotating oil splasher which in turn carries the oil to a conveyor trough for distribution to all wearing elements.

function only when a shaft is rotating within its respective bearing, and yet, continuously during such periods.

The pressure grease lubrication plug, on the other hand, has practically no storage capacity, and pressure is exerted on the lubricant only while the gun is attached and being manipulated. As a result, lubrication with such devices is intermittent, and therefore, renewal of grease must be carried out at comparatively frequent intervals, entailing of course, more or less labor and perhaps shutdown of certain machine tools.

Regardless of how a bearing may be lubricated by grease, as a general rule, it may be said that external lubrication is involved. That is, the lubricant is applied at the exterior of the machine. With oil, on the other hand, the use of a geared or plunger pump contained within a suitable oil reservoir permits of the attainment of practically internal lubrication. This will frequently be advantageous, especially where there may be possibility of lubricators or fittings being damaged or broken off in the handling of stock, or where cuttings or abrasive foreign matter may have an opportunity to gain entry into lubricators and bearings.

Selection of Greases

In the selection of any grease for machine tool lubrication it is important to remember that such a product is only as serviceable (from a lubricating point of view) as the oil which it contains. The soap content serves merely as a carrier for this latter to insure delivery to the wearing elements. This oil must, therefore, be a carefully refined product of a viscosity and pour test commensurate with the probable operating temperatures involved.

Importance of Proper Compounding

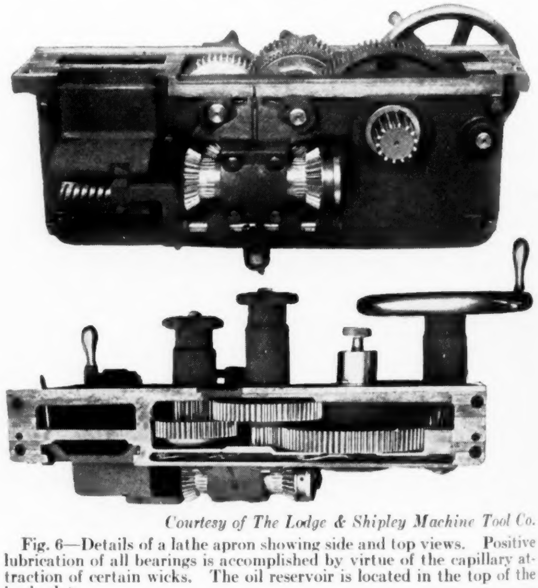
Greases for high temperature and high pressure service should be compounded with oils of comparatively heavy body. As a rule, highly refined steam cylinder stocks will possess the requisite viscosity, meeting as well, the high flash and fire point requirements.

In contrast where a grease is to be used under relatively low temperature conditions the pour test of the contained oil should be sufficiently low to preclude any possibility of congealment.

In all cases, regardless of service, the type of tool elements to be lubricated or the means of application, greases should be so carefully compounded as to remain in their intended state of perfect mixture. In other words, separation of oil from the soap content should not occur, for this might easily result in faulty lubrication, waste of oil and a general condition of sloppiness.

GEARING

Gearing as involved in the development of speed reductions is of decided importance in the operation of practically any machine tool. As a general rule splash or bath lubrication will be especially adaptable to such mechanisms.



Courtesy of The Lodge & Shipley Machine Tool Co.

Fig. 6—Details of a lathe apron showing side and top views. Positive lubrication of all bearings is accomplished by virtue of the capillary attraction of certain wicks. The oil reservoir is located in the top of the back plate.

Lathe Operation

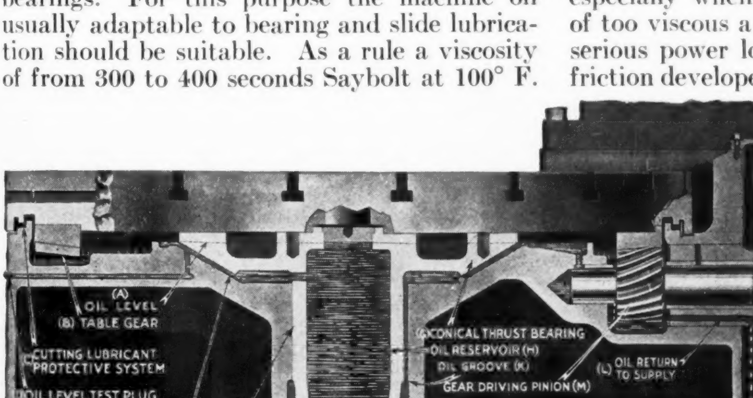
Take the lathe for example.

In most cases the speed of a lathe will be considerably lower than the speed of the driving motor; hence, the necessity for the several speed reductions usually found in the average

machine. Here power is transmitted to the spindle through a train of speed change gears enclosed in the head. Quick change gear feeds may be used for operation of power feeds; back gears are installed on certain types of engine lathes; and bevel pinions and gears are found in certain lathe aprons for the purpose of reversing the direction of feed.

Efficient operation is based primarily upon effective lubrication. This has been fully realized by the progressive machine builder and as a result speed change gears at least are usually equipped for bath or splash feed lubrication. Not only do these methods insure against the possibility of abnormal wear but also they render operation relatively noiseless and preclude the occurrence of back-lash. An added advantage is derived on account of the fact that usually the one lubricant can be made to serve both the gears and their shaft bearings.

In most machines the gears are comparatively small and so carefully designed, cut and aligned that unless excessive bearing wear takes place, lubrication can be effected by means of a relatively fluid lubricant, which will have sufficient viscosity to prevent metallic contact between the gear teeth and still be light enough to penetrate effectively to all the bearings. For this purpose the machine oil usually adaptable to bearing and slide lubrication should be suitable. As a rule a viscosity of from 300 to 400 seconds Saybolt at 100° F.



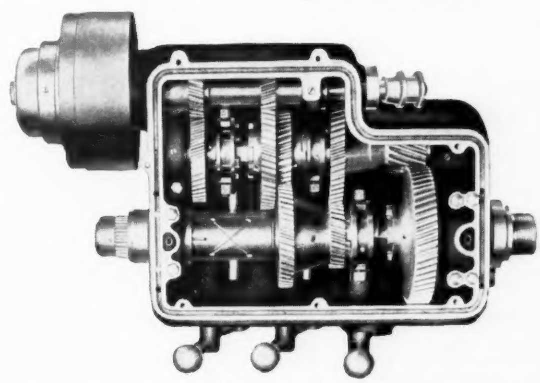
Courtesy of The Bullard Machine Tool Co.

Fig. 7—Details of lubricating system for the table drive and spindle mechanism in a vertical turret lathe. Oil is maintained at a constant level, a continuous stream flowing into the reservoir, and by the overflow, lubricating the table gear and pinion as well as the essential bearings. By specially designed guards dust, chips, or cutting compounds are prevented from contaminating the lubricating oil.

will meet requirements in a satisfactory manner.

In the case of vertical or larger types of horizontal turret lathes, however, a heavier bodied oil may be advisable for certain of the larger gears. This will be especially true where the gears are enclosed, but have their bearings so located without the gear case as to permit of independent lubrication.

In such installations, a viscosity of from 120 to 200 seconds Saybolt at 210° F. may be advisable, depending on the closeness of mesh and whether back-lash is prone to occur.



Courtesy of The Monarch Machine Tool Co.

Fig. 8—View of an eight speed, geared lathe headstock with cover removed. All gears run in a bath of oil, splash lubrication being thereby attained.

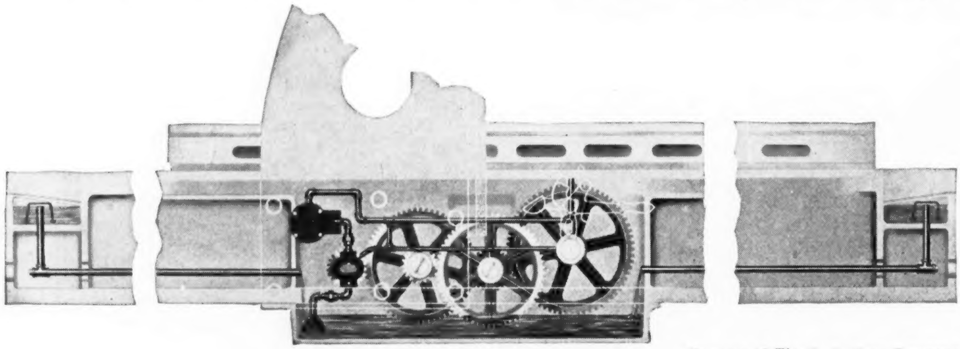
It must be remembered, however, that while a heavier lubricant will eliminate a certain amount of the noise of operation and the pounding and hammering due to back-lash, especially when speeds are changed, the use of too viscous a product might readily involve serious power losses on account of the added friction developed by the gears moving through the more or less inert bath of lubricant.

All machine gears, however, are not so enclosed as to permit of bath lubrication. The back gears of certain types of engine lathes, are examples. Such gears must therefore be lubricated by direct application of the lubricant to the teeth.

In service of this nature, the lubricant must not only be sufficiently viscous to preclude the occurrence of metallic contact between the teeth, but also it must be so adhesive as to stick tenaciously to these latter and resist the action of centrifugal force. Certain types of greases are capable of meeting the lubricating requirements, but their adhesive characteristics are so low as to render them readily subject to throwing off. As a result considerably more attention to their application would be necessary.

Straight mineral gear lubricants, on the

other hand, overcome this difficulty and meet both requirements admirably. Hence they are generally preferred for all such exposed gearing. In viscosity they should range from 1000 to 2000 seconds Saybolt at 210° F., according to the speeds, the tooth pressures involved and the temperatures of operation.



Courtesy of The G. A. Gray Company

Fig. 9—Phantom view of a modern planer oiling system. Note that centralized oiling of bearings, gears and V's, is provided for in this machine. Details of the lubricating system are clearly shown.

The Planer Drive

The gears on the modern planer are, in turn, generally regarded as being the most important parts of the machine, for their primary function is to drive the table. Perhaps this is the reason why certain authorities classify planers according to their style of drive, i.e., according to whether they are spur, helical or worm geared.

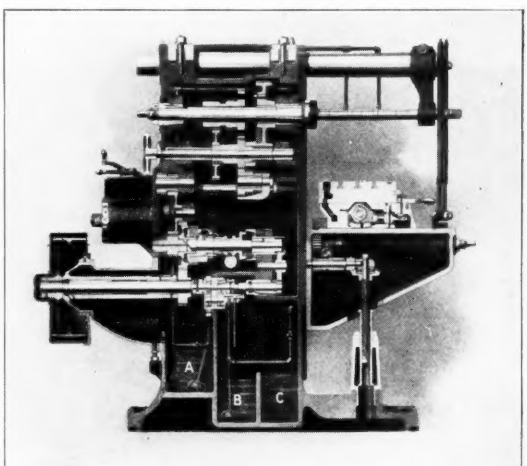
Either the spur or helical gear drive is usually preferred by the machine tool designer today. Both involve essentially the same principles of operation, the only real difference being in regard to the design of the gear teeth. Certain builders of helical gears claim that this type of tooth is not only stronger for the same width of face and pitch, but also that it permits of more complete rolling contact, thereby reducing a certain amount of the wear which sliding friction might involve.

In construction, a planer drive consists of a rack which extends over the length of the entire under side of the table. With this rack the "bull" gear or main gear of the driving train meshes. The intermediate set of gears which compose this train serve to bring about the necessary speed reductions from the driving element.

The arrangement of these gears is interesting due to the fact that quite a difference exists between the cutting and return speeds. As a rule, the latter will be from two to four times the former depending upon the size of the machine, and extent of cutting which may be necessary.

In the worm drive planer a worm takes the place of the "bull" gear; the table rack, however, remains the same. Worm gear reduction is claimed to have certain advantages over other types of gearing. It is well, however, to withhold the expression of any definite opinion regarding this. Suffice it to say, from a lubricating point of view there will be very little difference either way.

As a result this matter of gear lubrication is regarded by many as the salient feature of efficient planer operation. The occurrence of rolling and sliding friction between the respective teeth as they pass into and out of mesh has already been mentioned. Theoretically, this would take place whether the gears were run dry or not.



Courtesy of Kearney & Trecker Corp.

Fig. 10—Constructional details of a milling machine designed for automatic flood lubrication. The lubrication is stored in reservoir A, being pumped to the top of the machine for distribution to the wearing elements. Reservoirs B and C serve for storage and settling of cutting coolants and lubricants.

Actually, however, the continued occurrence of solid friction would tend to supplant rolling friction with sliding friction. Wear would thereby tend to increase proportionally.

The substitution of fluid friction for solid

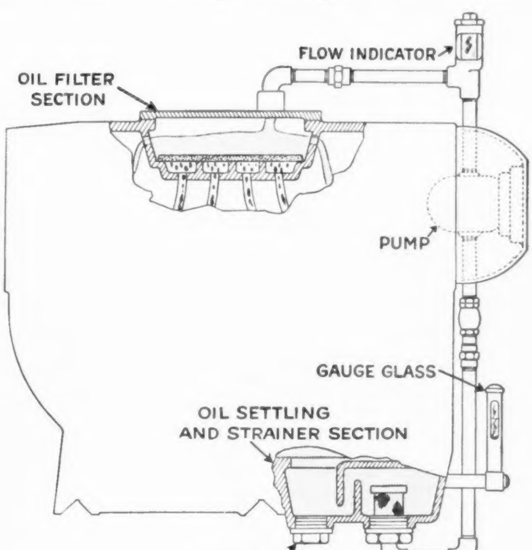
friction which is brought about by the use of a suitable lubricant which will permit of the formation and maintenance of the proper film over the gear teeth, will enable rolling contact to take place as originally designed for, unless faulty operation occurs, such as the gears working out of alignment.

Wherever gear lubrication must be carried out independently of the V's and bearings in the planer, the type of gears and their mode of operation must be taken into consideration, just as has been explained for the lathe. Therefore, lubricants as specified or used for these latter will be equally satisfactory if applied to the planer gears. The tendency is more and more to enclose all such gearing in an oil-tight housing; not only does this reduce the hazards of operation, but it enables more effective gear lubrication, and often-times eliminates the necessity for using the heavier lubricants so essential to exposed gears.

Milling Machine Gears

Splash and bath lubrication of gears, and frequently many of the bearings is also used on certain types of milling machines.

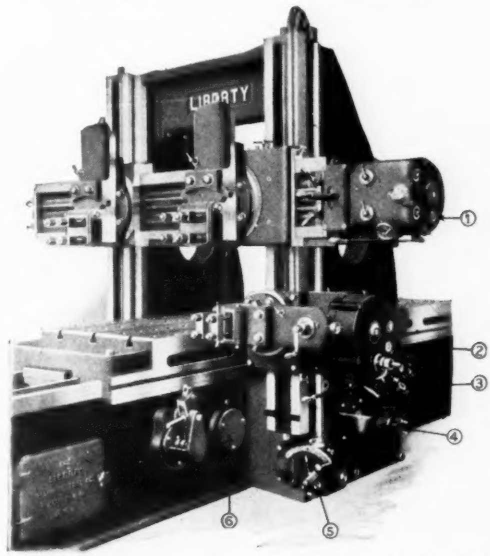
Such systems are particularly adaptable to column mechanisms, for with the gears of the drive shafts running submerged in oil, a sufficient amount of this latter is splashed to all parts of the column to effectively lubricate the bearings.



Courtesy of The American Tool Works Co.

Fig. 11—Details of a modern automatic oiling system on a lathe head. Here the oil is pumped by a Brown and Sharpe oil pump from a reservoir at the bottom, to a distributing chamber in the top cover as shown. Note that all oil is filtered through a felt pad prior to distribution to the bearings.

Here, however, the lubricant does its work under relatively low pressure, volume being relied upon to maintain the requisite oil films. Therefore, whereas a machine oil of perhaps 300 to 400 seconds Saybolt at 100° Fahrenheit, might suffice in a pressure oiling system, a heavier product even approximating a low viscosity mineral cylinder oil might be necessary for splash or bath lubrication.



Courtesy of The Liberty Machine Tool Co.

Fig. 12—View of a planer showing certain of the essential lubricating features, viz.: (6) The cap for enclosing the pressure lubricated bearing; (1) (2) (3) (5) The sight feed oil indicators; and (4) The force feed lubricating oil pump.

BEARINGS, GUIDES, AND SLIDES

In the Lathe

Lathe bearings may involve a number of types. For example, there will be the thrust bearings which take up the end thrust exerted by the spindle; these may be of the plain sleeve type or they may involve ball bearings. Other rotating members may be carried in plain babbitt or phosphor-bronze bearings, or in ball or roller bearings. In the case of the spindle, these should normally be capable of adjustment to allow for wear, etc.

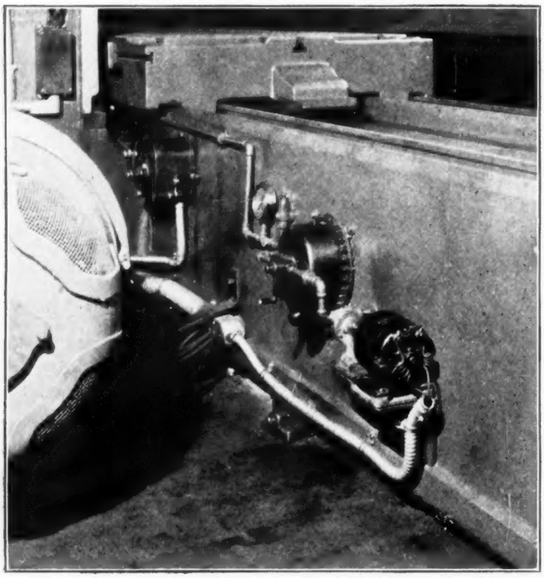
The higher the speeds, the more attention must be given to the bearings and of course, to their lubrication. It is for this reason that phosphor-bronze is so extensively used as a bearing metal for the high speed journals in lathe heads.

Slides or guides include the lathe bed on which the carriage moves, and the guides on which the turret saddle and cross-slide carriage travels.

Motion over a lathe sliding surface is relatively slow, but the pressures involved are high. Therefore, wear may easily become excessive, with the probability of increased power con-

sumption, if such surfaces are not properly constructed and lubricated.

Wherever abnormal friction occurs, the tendency will be for the lathe bed to wear hollow. For this reason, on most machines, it is built of



Courtesy of Motor Improvements, Inc.

Fig. 13—Details of the Purolator oil filtering device installed on a Cleveland planer. Piping is so arranged that used oil from the pump is filtered and returned to the storage tank prior to re-usage.

a high grade alloy steel and stiffened with box girders. In certain types of turret lathes, the bed is cast integral with the head to give additional rigidity.

The carriage is usually retained in position on the lathe bed by means of V-shaped projections which travel in corresponding grooves in the bed. V-lubrication is important due to the fact that abnormal wear therein will contribute to operating difficulties and the possibility of mis-alignment occurring. For this reason, sliding surface lubrication is receiving considerable attention in the progressive machine shop today.

One method of lubricating these is to install felt wipers in the sliding element or on the end of the carriage. These wipers furthermore aid in keeping the bed V's clear of dirt.

Other designs provide for automatic stream lubrication. Still others make use of revolving wheels located in the bedplate, which are so installed as to come in contact with the moving element as it slides over them. These wheels are usually located in a depression which can be partially filled with oil. Thus as they revolve, they carry a film of oil to the moving slide.

Cam Lubrication

While cams are not extensively installed on many types of lathes, it being found feasible to eliminate them in the design of the moving parts, certain machines will require them for the operation of the reciprocating turret slides, and the work-holding and feeding chucks.

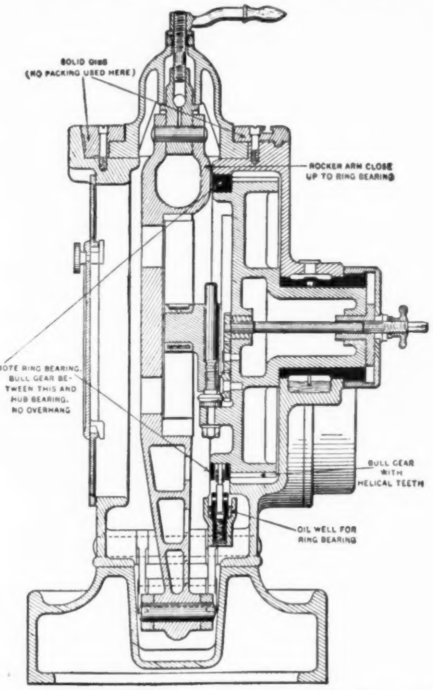
To attempt to describe their operation would require an extensive detailed explanation, therefore we will deal only with their lubrication.

Cams may involve much the same principles as do guides, or they may be based on a combination of rolling and sliding motion. Irrespective of their design, it is absolutely essential to prevent abnormal wear, otherwise lost motion and inequalities of operation will occur which will develop imperfections and inaccuracies in cutting.

Therefore, cam lubrication wherever involved, is a matter of moment and quite as important as the lubrication of guides and bearings. Certain machine builders have appreciated this to the extent of installing means for automatic flood lubrication.

The Planer

The essential sliding or bearing mechanisms involved in the average planer include the table V's or guiding grooves such as are de-



Courtesy of Niles-Bement-Pond Co.

Fig. 14—A shaper bull gear, showing details of the automatic lubricating system. Essential parts are noted on the sketch.

scribed for the lathe, which serve to keep the table in proper alignment with respect to the cutting tool; and such other guides as are necessary to hold the various reciprocating parts in position.

V-lubrication is naturally of chief importance, for upon the accuracy and extent to which these guides maintain alignment will depend the accuracy and degree of perfection of the work performed.

Planer V's are subject to considerably higher pressures and more wear than are these same parts on a lathe. For this reason they are generally lubricated by force feed or by means of automatic oil rollers of some form.

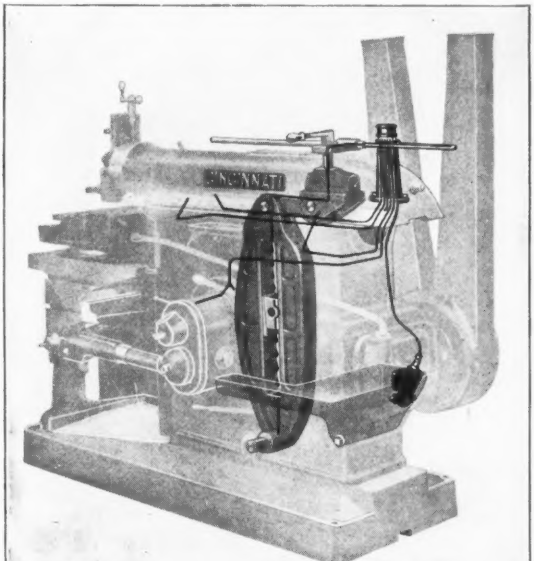
Where force feed lubrication is employed it is usually customary to have it serve not only the V's but also the guides, bearings and gears of the rail and other mechanisms. In such a system either a force feed lubricator or an oiling device including a suitable independent pump and reservoir may be used.

The force feed lubricator is the more readily attached to an existing piece of equipment.

Shapers and Slotters

Lubrication of the shaper or slotter differs but little from that of the planer. Essentially the same variety of operating mechanisms are involved, hence the same respective grades of lubricants can be used with equal satisfaction.

Automatic lubrication, while of course not universal, is nevertheless generally regarded as



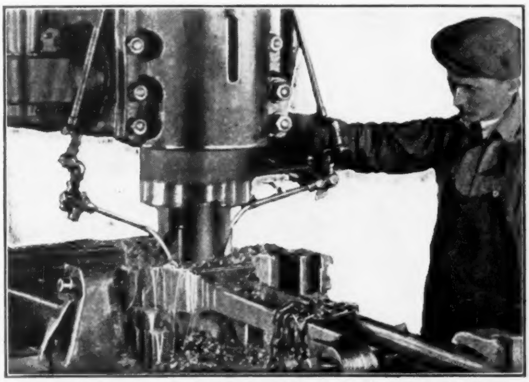
Courtesy of The Cincinnati Shaper Co.

Fig. 15—Phantom view of the lubricating system of an automatically oiled shaper. This includes a plunger type pump, a sight feed distributing station as shown, etc. Wicks serve to feed the oil from this point to the individual parts of the machine via suitable piping. Clean, positive lubrication is, therefore, assured.

an advantage by many leading machine builders. In fact, one manufacturer creates an analogy between his shaper and the automobile in order to drive home the importance of lubrication.

In these machines pressure lubrication by means of oil, involving some form of plunger or geared pump is applicable, just as it is to the planer and certain other types of tools.

On deep cutting of hard steel especially, will



Courtesy of The Ingersoll Milling Machine Co.

Fig. 16—A milling machine in action, showing the type of service that is frequently demanded. Heavy duty, imposes a decided load on all wearing elements and requires careful attention to their lubrication.

the pressures exerted on some of the gears and bearings be quite material.

Where clearances are relatively high wear might not become abnormal for the lubricating film would be thicker. But high clearances are not conducive to accurate cutting, therefore, they should be always kept within the limits of practical operation. This, however, might interfere with the maintenance of a suitable lubricating film, especially where hand oiling is relied upon. So it is in the interests of economy of upkeep and maximum production to resort to automatic lubrication as a general rule.

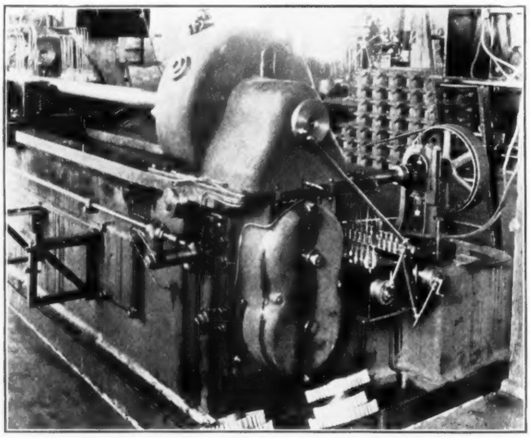
Milling Machines

In the development of the modern milling machine there has also been a decided trend towards automatic lubrication of bearings.

A milling cutter performs its work at a single pass and removes metal at a relatively rapid rate. Therefore, it is absolutely necessary that the work table, spindle and all supports and operating mechanisms be so designed and constructed as to involve no tendency for the work to spring away from the cutter when it is subjected to the strain of cutting.

It would not suffice, however, to rely upon rigidity and strength alone to take up these cutting strains. Wear on all frictional elements would only be probably increased in proportion. Therefore, positive lubrication must be resorted to. That is, lubrication so carried out that a continuous feed of oil is directed to all these wearing parts under sufficient pressure to preserve a suitable fluid film between them and prevent metal-to-metal friction.

The extent to which such a lubricating system would have to be planned would, of course, depend to a large degree upon the working pressures which might be developed. To meet such conditions, some milling machine builders have found that the installation of suitable oil reservoirs or independent force feed lubricators not only simplifies their problem, but affords quite the necessary amount of lubrication, even though the bearings, etc., are not flooded with oil.



Courtesy of S. F. Bowser & Co., Inc.

Fig. 17—An Allis-Chalmers six bar boring mill equipped for force feed lubrication. Note the ratchet driven lubricator in the right foreground and the numerous oil leads to the various working parts.

In contrast there are other builders who regard flood lubrication as so essential that they have designed their machines with absolutely self contained oiling systems, the lubricant being pumped to the wearing parts by means of a suitable pump adjacent to or located in the oil reservoir itself. Thus, throughout operation a flood of oil is continually passing over all gears and bearings. In such a system the one grade of oil, i.e., a medium viscosity straight mineral machine oil would usually give satisfactory lubrication of all the wearing parts involved.

DRILLS AND BORING MILLS

The larger machines of this type are termed boring mills. Their essential function is to bore out machine parts, such as car wheels, engine connecting rods, etc., and differential housings or crankcases in the automotive industry. In fact one of the most frequent functions of a boring machine is to drill or bore out the aperture, which is to ultimately house a shaft and its accompanying bearing.

Boring machines or mills are built either horizontally or vertically, according to the work which is to be handled.

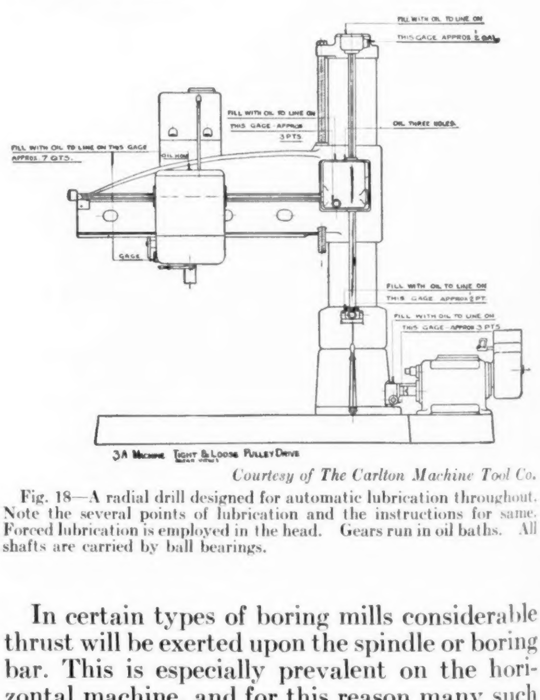
The horizontal mill is adaptable to work which cannot be readily revolved, the tool, therefore, being the rotating element. This machine is also suited to the boring of long or deep holes and the boring of more than one hole in the same piece especially where these holes are located in different planes.

An additional feature of the horizontal boring mill is that it has a wide field of application, being capable of not only boring but also milling and drilling.

The vertical boring mill, on the other hand, is more especially adapted to work which can be revolved. In other words it is used for work which can be fastened to the table and rotated thereon. As a rule, therefore, machine parts of relatively smaller caliber, such as pulleys, gears, piston heads, machine discs and casings, etc., are finished on vertical boring mills. These machines are claimed to reduce the effects of centrifugal force due to the fact that the work can be more easily balanced.

Essentials of Lubrication

Boring mills involve much the same type of wearing parts as the lathe, or planer, etc. In other words there are the driving gears, the feed and traverse gears, the screw by which the table and saddle are adjusted, the V-tracks on which the saddle rests, and the miscellaneous bearings and guides involved in connection with the above.



Courtesy of The Carlton Machine Tool Co.

Fig. 18—A radial drill designed for automatic lubrication throughout. Note the several points of lubrication and the instructions for same. Forced lubrication is employed in the head. Gears run in oil baths. All shafts are carried by ball bearings.

In certain types of boring mills considerable thrust will be exerted upon the spindle or boring bar. This is especially prevalent on the horizontal machine, and for this reason many such mills are built with V-tracks on either side of

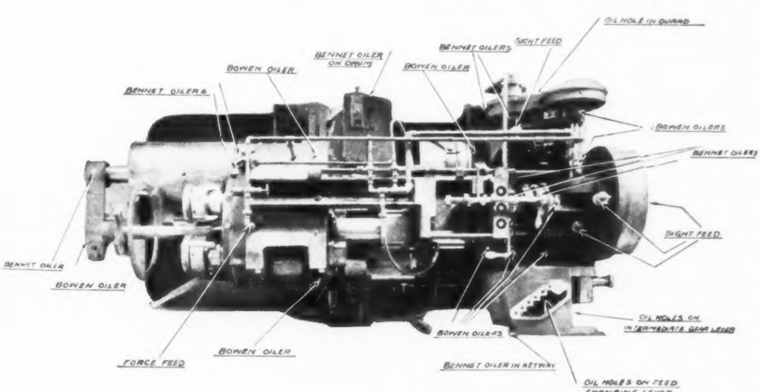
the spindle. These V's take up the thrusts of operation effectively, provided they are properly lubricated.

Experience has proven that in general all the above parts of a boring mill will function most satisfactorily if provision is made for pressure lubrication. Builders have realized the enormous pressures which must sometimes be carried by certain of the wearing parts of their machines.

They have furthermore realized that where equipment of the size and complexity of the boring mill is involved, the most dependable results are attained if the operator is not expected to combine the duties of an oiler with his more specific duties of producing the maximum of correctly machined products.

For the general lubrication of boring mills a medium bodied straight mineral oil has been found to be most satisfactory. Essentially it must be of the same characteristics as the oil used elsewhere in the shop. For all round lubrication a viscosity of from 300 to 400 seconds Saybolt at 100° Fahrenheit will be usually found to be suitable. Such an oil will have sufficient body to not only serve the bearings, but also the slides and enclosed gears, where it is delivered under sufficient pressure.

Where gears are not enclosed in oil tight casings, or, on rack, worm or screw mechanisms a somewhat heavier product might be advisable. Usually a viscosity of approximately 1000 seconds Saybolt at 210° Fahrenheit would suffice for such service. For other gearing which operates enclosed and designed for splash lubrication a straight mineral oil of a



Courtesy of The National Acme Co.

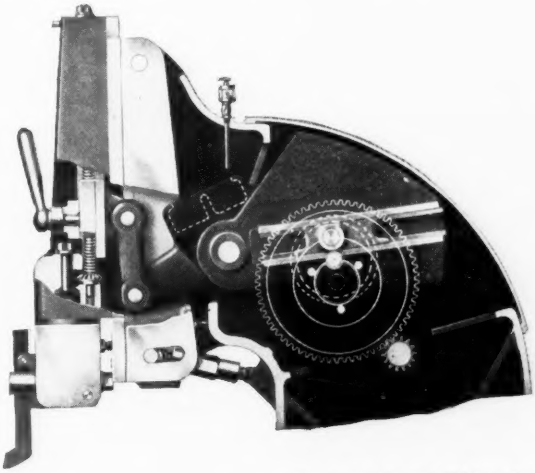
Fig. 19—Top view of a model "G" Gridley showing points of lubrication and types of oilers installed.

viscosity akin to a light steam cylinder oil would probably serve the purpose best.

Drilling Machines

Where boring operations involve the tapping of relatively small holes, reaming or counterboring, either singly or in multiple, drills of vertical, radial, horizontal or multiple-spindle-type are usually employed.

High speeds are advantageous in drilling on account of the fact that breakage of drills or



Courtesy of Pratt & Whitney Co.

Fig. 20—A section through the rocker arm and ram of a vertical shaper, showing the various ram adjustments and provision for lubrication.

cutting tools is reduced, temperatures of cutting are often lower provided adequate means is employed for directing the cutting coolant to the face of the tool, production is increased and there is less chance for burrs being formed.

Lubrication Details

High speeds and maximum production, however, are only possible provided the working parts of the drill function absolutely in unison with respect to one another. To bring this about, lubrication is the logical recourse assuming that the machines are properly designed and constructed.

Centralized automatic lubrication has been developed to a marked extent in this connection, and is today claimed to solve the lubrication problems so inherent to vertical bearings and high speeds. The essential purpose, of course, is to insure a sufficient supply of lubricant to all wearing parts of the drill. This should be borne in mind irrespective of the design of the equipment or the means provided for rendering it automatic, although of course it should never be so complicated as to involve difficulty in repair, or

abnormal possibility of breakdown. It is also well to mention that centralized automatic lubrication makes possible the use of one grade of oil, thereby reducing expense and the possibility of difficulty due to application of the wrong product at any time.

In connection with gearing, however, as with boring mills and other tools, there are, of course, some cases where these mechanisms will be designed for individual or separate lubrication. Naturally bath or splash oiling is preferable, and in such instances the same products heretofore specified under boring mills would be suitable.

Exposed gearing or other toothed mechanisms running perhaps in non-oil tight casings, on the other hand, will require a heavier product which will maintain an effective lubricating film on the teeth notwithstanding any action of centrifugal force which may be prevalent.

OTHER TYPES OF MACHINE TOOLS

Other machine tool equipment such as the grinder, screw and thread cutter, hobbing machine, chucking machine, etc., while to an extent more limited in application than the more massive tools already discussed, cannot justly be classified as auxiliaries, even though they may amount to this in many shops. Their functions are distinctive, and quite as important in finishing certain types of work as these other machines.

The essential principles of operation will be much the same, i.e., the working of the material into suitable shape and design for subsequent use as tools or machine parts. This is brought about by cutting as in the gear-hobber, or by grinding as in the grinder. This latter machine is also used for buffing and polishing purposes. In consequence such equipment will function by virtue of suitably arranged gearing, bearings for the rotating members and guides or slides for such parts as may be reciprocating in their motion.

Lubrication Requirements

Lubrication will therefore differ but little from that already discussed. While the use of independent oil and grease cups will often be the most economical and satisfactory equipment, automatic or flood lubrication, is also provided for by certain builders. It all depends on the design, the speed at which the machine is to operate and the bearing or frictional pressures which may be involved.

In consequence the same varieties of lubricants as recommended elsewhere in this article will in general be applicable to similar wearing parts on these machines. For example, in splash or force feed lubricating systems a 300 to 400 viscosity machine oil should be used. For grease cups, in turn, dependent on whether they are of the compression, pressure gun or pin type, a grade of grease should be used which, under the operating temperatures involved, would liquefy to just the right degree to afford proper lubrication.

CONCLUSION

Automatic lubrication has been stressed throughout this article and every opportunity taken to further an insight into the working details of the more accepted lubricating systems in use today in the machine tool industry. There will of course, be a natural preference on the part of the lubricating engineer for automatic lubrication, due to the extent to which it promotes efficient operation, economy in lubricants, and increased production.

It should not be assumed, however, that individual lubrication of many bearings, etc., is not perfectly feasible and oftentimes the most economical procedure. It is all a matter of machine construction, and operating requirements.

In the case of individual lubrication, however, due consideration must always be made for the lubricating requirements of the parts involved, the labor conditions and the safety of the operators.

On intricate massive machinery, of course, where lubricating requirements are frequently severe, splash, automatic pressure or bath lubrication will in general be probably the most satisfactory.

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